THE INDONESIAN JOURNAL OF BUSINESS ADMINISTRATION
Vol. 2, No. 16, 2013:1936-1946-1956

ANALYSIS AND PROPOSED CHANGES OF TIN ORE PROCESSING SYSTEM ON CUTTER SUCTION DREDGES INTO LOW GRADE TO IMPROVE ADDED VALUE FOR THE COMPANY

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Abstract - Mining technology using Cutter Suction Dredges (KIP) is currently performed by PT Timah (Persero) Tbk. Currently tin ore processing system in KIP produces high grade tin ore (±70% Sn). By applying high grade tin ore processing system in KIP, recovery of tin ore is low and associated minerals of tin contained in concentrates secondary jig will be wasted. To change the processing system to be low grade in KIP be enough to negate the sluice box equipment, because the secondary jig produces concentrates of tin ore with low grade levels. System changes tin processing in KIP be low grade, the consequences will transport tin ore to Mineral Processing Plant (PPBT) with a larger amount so that it will add the cost of transportation and processing costs in PPBT. By using production data in 2012, when the operating KIP converted into low grade, the tin is generated by changes in the system amounted to 741,02 tons and will be gained by economic value amounting to Rp. 115.752.676.478,- To implement a system change in tin processing KIP from high grade into low grade to note any factors which are very critical and critical factors. The main requirement of resources is human resources, financial resources, and information technology. Success factor the changes system is at capacity ocean freight, recovery PPBT and management support, so that the system changes in Cutter Suction Dredges tin ore processing of high grade into low grade will succeed.

Key Words : Cutter Suction Dredges, Mineral Processing Plant, Sluice Box, Tin Ore High Grade, Tin Ore Low Grade,Recovery.

1. Introduction

Tin ore production of PT Timah (Persero) Tbk are mostly generated by business partners, be it through onshore mines as well as from off-shore mines (Cutter Suction Dredge, KIP). In the production process, the partners produced a tin ore with high grade(±70% Sn), which was then taken to the Unit Metalurgi smelting in West Bangka and Unit Timah Kundur smelting. Business partners cleaning the tin ore own up to produce tin ore high grade with simple washing equipment. On Cutter Suction Dredge, instrument laundering existing only using the jig and sluice box, whereas in mine land generally only use sluice box. With this processing equipment recovery of tin ore processing expected very low, because according to the law of mineral processing, the higher levels resulting in one process, then recovery the process will be getting lower (Wills, 2006 : 17)

With this processing system, tin ore produced is not maximum because many tin ore wasted through tailing, besides opportunities to obtain other minerals, as monazite, xenotime, zircon, ilmenite, etc getting smaller, in this minerals contain metals prized as rare-earth metals. In this research will be discussed on the tin ore processing system changes on Cutter Suctin Dredges (KIP), when make the change of the high grade to be low grade until obtained calculation economic values by change in the system and whatever will change from the side of operation.

2. Business Issue Exploration

The succes of the process of washing ores in a Cutter Suction Dredge tin production affected various factors such as the type of election equipment, washing equipment, quality maintenance operators who run the equipment, quality raw material to be processed, the method mineral processing and so on. On the current operating strategy implemented by PT Timah (Persero) Tbk for the washing of the Cutter Suction Dredge is to produce high grade tin ore (±70% Sn). But long before any Production, with a Bucket Line Dredges technology, tin ore washing done by producing low grade levels (20-30% Sn).

A. Conceptual Framework

To improve performance the tin ore processing on Cutter Suction Dredge, need to set out a method of washing that can catch more of tin ore from the mining process. The factor of human resources was also influential in the success of the process of washing of tin ore on Cutter Suction Dredges, because by using the jig equipment, required operators who could do Setup jig equipment according to the raw material to be processed, such as length of stroke, the frequency of spanking, smooth over jig layer and so on.

Thus will hopefully get maximum possible the tin ore from the mining process with a Cutter Suction Dredge. In Figure 1 is described as a conceptual framework to maximize the success of the washing of tin ore in The Cutter Suction Dredge by applying processing systems of low grade.

In Figure 2. the root causes analysis of the problem is described that can affect the success rate (recovery) of tin ore processing on Cutter Suction Dredge.

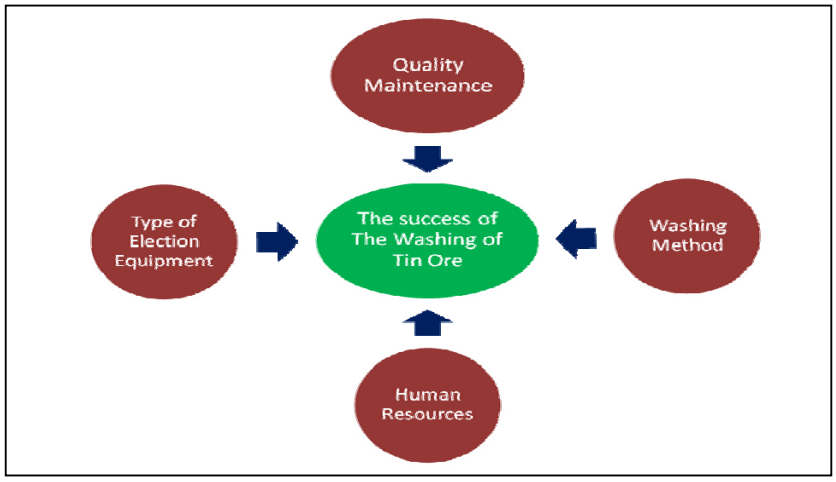


Figure 1. Conceptual Framework The Success of the Washing of Tin Ore

B. Method of Data Collection and Analysis

In this study the approach used is through the data capture in Unit Laut Bangka as operate Cutter Suction Dredges in PT Timah (Persero) Tbk, and processing the data to find out how economical advantages are obtained when the change ore processing system on Cutter Suction Dredges by eliminating sluice box equipment. Phase retrieval/data processing are as follows :

1. To get data results of mineral processing on Cutter Suction Dredges in Unit Laut Bangka, where results were still using the sluice box as a tool of the last process of washing, especially tailings from sluice box analyzed in a lab to find out what percent of tin levels in the tailings of the sluice box and how many kilograms per hour of tin are thrown back into the sea. Tailings taken with a special tool and measured speeds the flow of tailings sakan. Tailing sand that is then weighed,

then analyzed the content of Sn, to find out what percentage of Sn is wasted through tailings per hour.

2. Taking data production Cutter Suction Dredges of tonnage and hours operating for 2012, both owned company or belonging to business partners, to calculate what tin wasted to sea through tailing based on hours operating equipment processing KIP of all KIP operating in company.
3. Calculate how much a tin ore would be obtained in PPBT when all production KIP transported to PPBT.

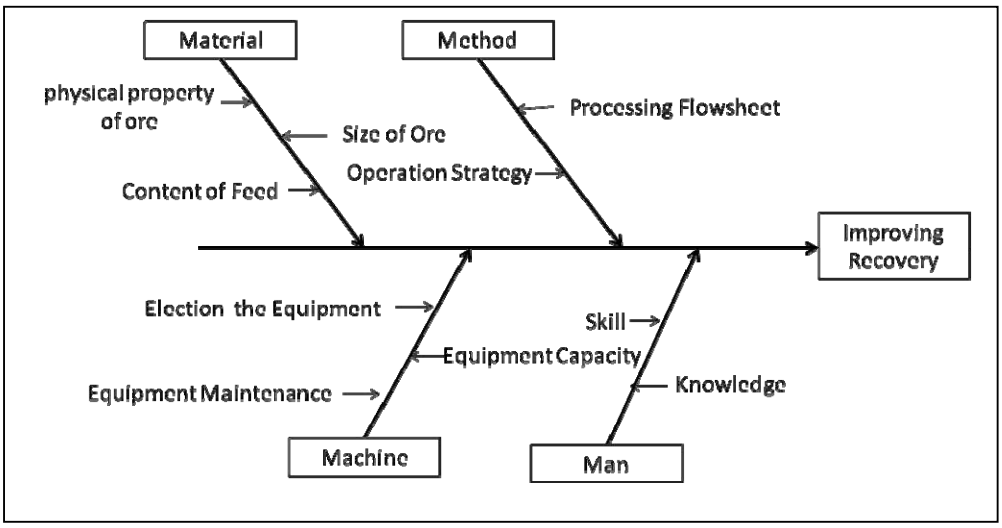


Figure 2. Root Causes Analysis Tin Ore Processing

4. Calculate what the cost of transporting ore from KIP to PPBT when implementing systems acceptance of low grade (no sluice box). Calculation of the cost of transport also takes into account the moisture content in the ore of Tin. Then calculated the difference in the cost of transporting the ore of tin high grade levels compared with the low grade levels.
5. Calculate how much economic value obtained with an increase in the recovery of tin ore processing, calculate how tin metal value is obtained by reducing the cost of transporting and processing fee at PPBT as well as the cost of smelting.

The limitation issue in this research is as follows :

1. The washing system is observed only on three units of Cutter Suction Dredges; KIP Timah 1, KIP Permis, and KIP Penganak. The third is the KIP's company so much easier driving operator in the KIP to perform research activities, than if doing research at KIP's business partners.
2. Production data taken is 2012, started January until December, so that the data processed to get economic value of system change of tin ore processing.
3. The addition of economic value are discussed only on the acquisition of mineral ore of Tin, the others mineral is not counted in value, because the current mineral of tin follow-up still kept in the form of a mineral, not to change the form of the metal, so its economic value has not been calculated. Currently company being built a pilot plant for the processing of tin minerals follow-up to get a rare earth element is a fairly expensive price.

C. Analysis of Business Situation

Currently, PT Timah (Persero) Tbk operates 53 Cutter Suction Dredges units that are scattered in Bangka Marine and Kundur Marine, reduced from data the number of KIP in 2012, because some KIP's business partners do not meet the eligibility requirements so that its permissions extended operation in 2013. As many as 15 units belong to PT Timah (Persero) Tbk. Figure 3 describes a Cutter Suction Dredges.

In General tin ore processing on KIP consisted of 2 series jig, primary jig and secondary jig, as well as additional equipment of sluice box. Primary Jig consists of 4 units of jig, with the kind of Pan America. This jig consists of 2 row and each row has 3 compartments A, B, and C.
While the secondary jig consists of 2 units of jig, with the kind of Pan America with 2 row respectively there are 4 compartments A, B, C, and D.

Generally, the tin ore processing in KIP goes as follows. Feed is sucked up from the sea floor continues to rotary screen to be separated from the rocks or a large sized material cannot be processed in the jig. After that the feed will

Figure 3. Cutter Suction Dredges

go to the primary jig to do washing of the first stage. The concentrate will be put together and distributed to secondary jig to experience the second stage while washing tailings will be dumped into the sea. From this second phase of washing resulting concentrate that will be further processed using the sluice box while the tailings are dumped into the sea.

sluice box is a simple concentration process equipment made of wood. This equipment is operated manually with the help of media water. The concentrate processing results using secondary jig is collected and placed on the sakan and then sprayed with water. Due to the considerable weight difference between Tin with gangue minerals, which is mostly in the form of quartz, then the tin ore will be left behind in sluice box, and gangue minerals will drift carried by the flow of water. This process is done over and over again to get a clean Tin from the polluter. The process of washing of tin ore in the Cutter Suction Dredges can be seen in Figure 4.

Sluice box is a simple equipment that can produce content of Sn in high concentrate (high grade with 70% Sn) but because the process of washing is very dependent on the skill of man operating, the value acquisition (recovery) sluice box is quite low and the quality of the concentrate results processing sluice box is unstable. This means many tin ore wasted into the tailings, as well as the potential loss of tin minerals followup. By eliminating the use of the sluice box is expected to minimize the loss of tin and mineral followup into the tailings.

There are currently PPBT in five areas, namely PPBT Pemali in Bangka, PPBT Mentok and PPBT Jebus in West Bangka, PPBT Toboali in South Bangka, and PPBT Kundur in the Riau Islands. But the current operation is currently only PPBT Mentok and PPBT Kundur because of limited tin ore processed by

the company at this time. According to the explanation from earlier that concentrates KIP directly in the form of high grade, so it does not need to be processed in PPBT. With the proposed changes to the system of ore processing in KIP, then concentrate from low grade levels with KIP will take to the PPBT Mentok and PPBT Kundur.

Washing Plant in PPBT Mentok is equipped by 4 primary jig types Harz Jig, each of which has 4 compartments A, B, C, and D, as well as 2 secondary jig type of Yuba that each have 2 compartments A and B at wet processing. To get to the dry processing, concentrate will be dried before using the Rotary Dryer. In dry processing, used tools, among others, High Tension Separator (HTS), Air Table, and Magnetic Separator. Tailings from the Washing Plant will be processed in a jig that is outside

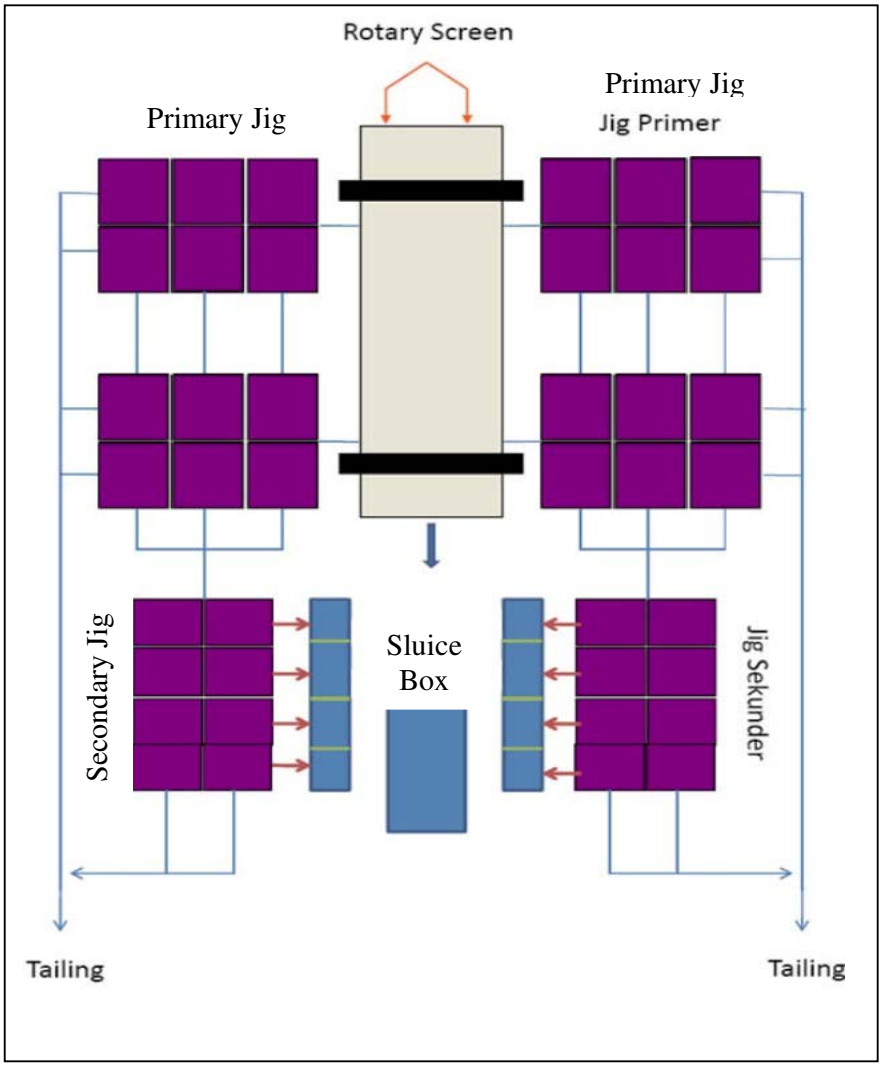


Figure 4. Tin Ore Processing in the Cutter Suction Dredges

the area of the Washing Plant. In a series of such, there are 5 units primary jig type of jig yuba as well as two units of secondary jig type of yuba. Tailings from the outside jig would be final tailing of tin ore processing. Flowchart tin ore processing on PPBT Mentok can be seen in Figure 5 below.

In addition to the washing of tin ore, PPBT Mentok also produces followup minerals naturally washed with cassiterite such as ilmenite, zircon, monazite, and xenotime.

Ilmenite ($FeTiO_3$) commonly used as raw material for synthetic rutil (TiO_2) for industrial ceramics, pigments and concentrates the metal Titanium. Zircon ($ZrSiO_3$) is itself a zirconia raw materials for ceramic industry. While monazite ((CeLaYTh) PO_4) and xenotime (YPO_4) is a raw material for the manufacture of REO (Rare Earth Oxide) to ceramics industries as well as rare earth element concentrate also as a source of uranium and thorium to fuel nuclear reactors. That minerals on the periodic sale from Bangka Belitung depending on consumer orders and production, but still have a low economic value, since it has not been through the process of processing into precious metals.

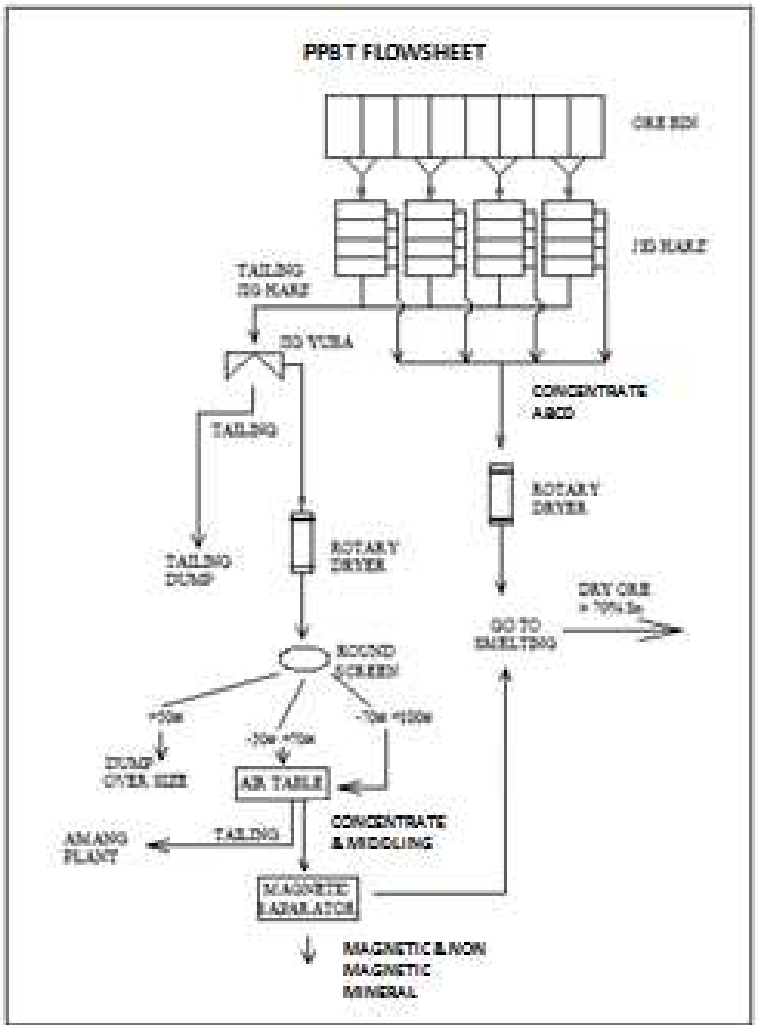


Figure 5. Flowsheet Tin Ore Processing on PPBT Mentok

3. Business Solution

The only way to optimize recovery in KIP is by producing tin ore with low grade levels in KIP, then low grade ore is brought to PPBT to be processed into high grade, because PPBT has a more complete equipment and the process can be repeated, so that totally discarded as tailings have very small contents of Sn. This has actually been done on process of ore processing on the Bucket Line Dredges, but low grade admission policy for KIP has not been implemented by the company at this time. To change in order to get a low grade levels in KIP, just by eliminating equipment sluice box in KIP, as the concentrate from the secondary jig have around 25% Sn (low grade levels), after that the tin ore was brought to PPBT to be processed into high grade ore (contents ± 70% Sn).

Based on the data of sampling conducted in Unit Laut Bangka PT. Timah (Persero) Tbk as of January until December 2012, there are 7.417 kg Sn/hour kilograms of tin is wasted with tailings per hour into the sea, due to low recovery of tin ore processing by using the sluice box. Contents of Sn to be brought to PPBT by using low grade system, obtained from the results of analysis of samples of concentrated secondary jig, which is done by Unit Laut Bangka of January until December 2012, obtained contents of secondary jig concentrated will be sent to the PPBT levels of Sn have 26.33%. The total number of the washing equipment operating the whole company's KIP in 2012 is 123,613 hours, and the median loss of tin ore 7.417 kg Sn/hour, then in 2012 the company has lost the opportunity to get a tin ore 916.88 tons if all tin ore had an entire sluice box equipment is brought to PPBT to be processed.

See an opportunity wasted tin ore back to sea with tailings, then need a system change or tin ore washing/processing method in KIP. Changes to this method will cause some changes in terms of operations as follows:

1. The amount of tin ore to be transported from KIP to PPBT will experience an increase in the tonnage of 2.802 times.
2. Tin ores processed in PPBT will increase, for it to be aware of the capacity of PPBT is able to process the ores of tin with the change of the system.

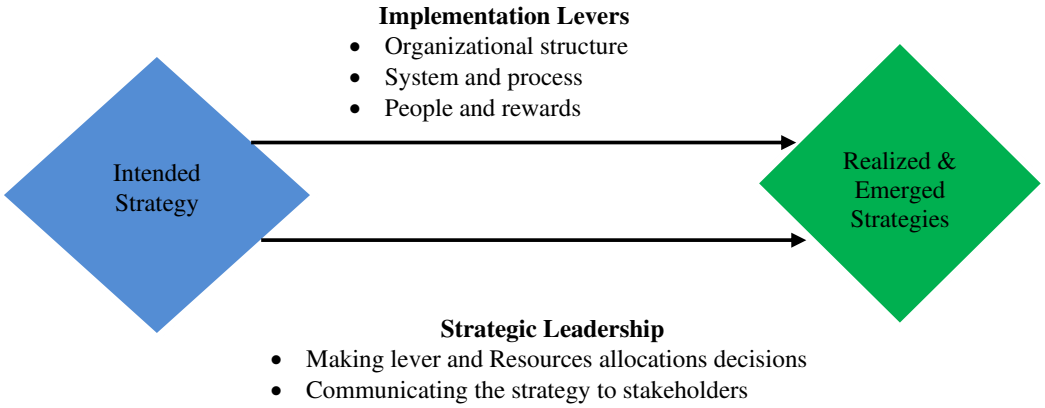
In terms of the ability of sea transport (number of tug boat and barge), current PT Timah (Persero) Tbk has a fleet of ocean freight reasonably sufficient so there is no need to do the addition of ocean freight fleet when processing system changes on Cutter Suction Dredges into low grade. To improve the efficiency and effectiveness of transport of low grade tin ore from KIP to PPBT, tug boat which was used not to wait until barges filled to capacity at the site of the operation existing at present as KIP. Empty barges provided backup in each area of operation so that when a barge filled with tin ore, then the new tug boat back from PPBT with an empty barge will direct barges already filled back to PPBT. When tin ore to be transported from KIP to PPBT was in the form of low grade, then the difference in the cost of transportation of tin ore in a changing system of high grade was low grade has increased Rp. 8,421,506,079.

PPBT Mentok capacity installed is of 108,000 tonnes/year and in accordance with the effective operating in 2012 by 73.42%, PPBT Mentok can be operated with a capacity of 70,004 tons/year. If there is a change in the tin ore processing system of high grade into low grade, then in 2012 PPBT Mentok would be processing tin ore of low grade 39,859 tons from KIP plus 4,330 tons of Bucket Line Dredges (total 44,189 tons), thus PPBT Mentok is still able to process tin ore from KIP to the ore processing policy changes. Capacity installed of the PPBT Kundur is of 57.600 tons/year and in accordance with the effective operating in 2012 by 77.29%, PPBT Kundur can be operated with a capacity of 44,520 tons/year. If there is a change in the ore processing system of high grade into low grade, then in 2012 PPBT Kundur will prepare the tin ore of 18,219 tons of low grade tin ore from KIP plus a tin ore from the Bucket Line Dredges of 10,945 tonnes (total 29.164 tonnes), thus PPBT Kundur still able to processing of tin ore from KIP with a policy change.

Mineral Processing Plant (PPBT) has the capability of production with the recovery of 98.85% in 2012. If the feed from the production with low grade of KIP (26.63% Sn) sent to PPBT of 58,077.79 ton, then the resulting concentrate is 15,116.02 tons. Thus losses of tin in PPBT of 175.86 tons. But compared with the opportunity to get the tin ore due to loss in the ore processing of KIP (sluice box) amounted to 916.88 tons, then there is still a chance to get a tin metal weighing 741.02 tons of Sn in the tin ore was sent to PPBT. The cost of the tin ore processing in PPBT Fixed Rp. 1,557,374.-/ton Sn is generated. The cost of smelting tin ore to produce tin metal in Unit Metalurgi fixed in units of USD 1,302/ton Sn is generated, with the recovery of melting in the Unit Metalurgi Mentok during the year 2012 of 99,88%. By entering the number of fusion recovery, it will be generated in tin metal ready export amounted to 740.14 tonnes. The additional benefit gained from system change ore processing in KIP from high grade into low grade of is Rp. 115,752,676,478.-

4. Conclusion

With given the importance of economic values will obtained by tin processing system change on Cutter Suction dredges from high grade to be low grade, advised to the company as soon as possible to change the system of tin ore processing on Cutter Suction Dredge.



Source : Carpenter & Sanders, Strategic Management: A Dinamic Perspective, 2007

Figure 6. The Aspect of Decisive Implementation Strategy

5. Implementation Plan

Implementation of the strategy is the realization of the strategy proposal has been selected, where the proposal was elaborated further in order to give an advantage. Carpenter & Sanders (2007; 309) mentions that there are two aspects that influence the implementation strategy; implementation lever and strategic leadership. Both of these aspects will serve as the framework for the implementation of the changes washing system on Cutter Suction Dredges.

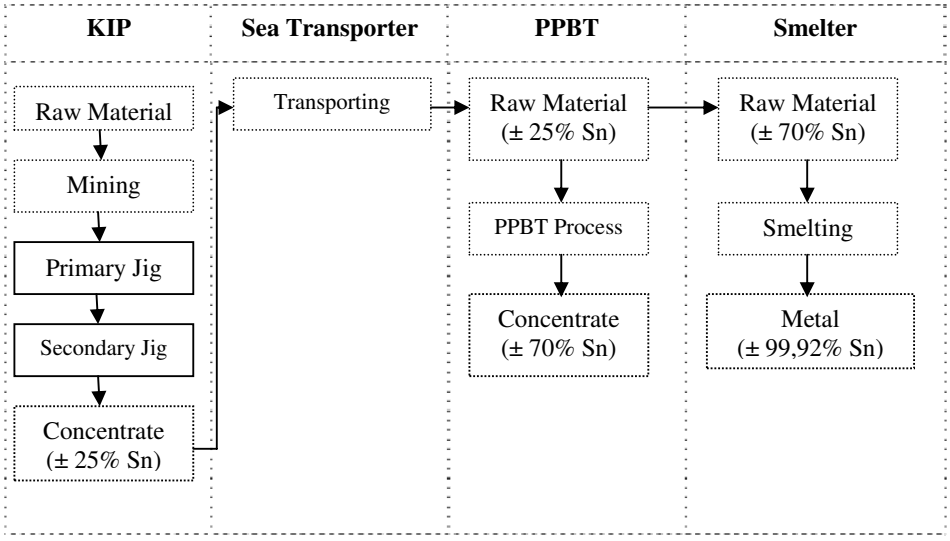


Figure 7. Proposed Ore Processing System Change in KIP

a. Implementation Levers

Is a mechanism that must be owned by a company to assist in the implementation of the corporate strategy. Some of them are organizational structure, system and process, people and rewards.

- Organizational Structure, is the organization structure of PT. Timah (Persero) Tbk, there will be changes to the structure of PPBT, if the ore processing system change. As the organizational structure in the PPBT of the original implementing office hours 8 hours a day will be changed to shift system (24 hours a day).
- System and Process, is operational activities in Cutter Suction Dredge, the process of transporting ore, and process in PPBT. With the change of ore processing system in KIP, operation process will change, because of the resulting ore with high levels (high grade), it should now be processed further in PPBT, which will result in the addition of volume transport and processing ore at PPBT. Proposed changes to the system of tin ore processing in KIP to get tin metal ready exported can be seen in figure 7 below.
- People and Rewards

  People are employees of PT Timah (Persero) Tbk and employees of business partners who operate KIP in company mining concesion area. They are actively involved in the operations of tin ore haulage KIP, from KIP to PPBT and PPBT employees. The number of personnel will increase in the transportation of tin ore and PPBT because the addition of tin ore is transported and processed. Reward is closely associated with people because the reward is recognition of work and achievements is a performance controller tools so implementation can proceed. There is a form of reward that can be arranged whether it is material or immaterial, to the employees themselves can be either incentives, promotional work, increased work space area, training and others. Needs to be given to the employee by the bonus system, due to the influence of the increased intensity of work performed by employees. For the business partners who run this program could be given in the form of additions to the value of the contract for the mining activities.

b. Strategic Leadeship

The management of PT. Timah (Persero) Tbk acts as a decision-maker for the implementation of this change because it

concerns the relationship of cross-business unit, which serves to:

- Determine the allocation of the levers and resources companies, especially the addition of employees needed, increased operational costs, as well as the addition of other fees.
- Communicate strategy arranged to key stakeholders

Based on the above framework, the proposed implementation plan in the ore processing system changes in KIP with a system low grade reception are as follows:

1. Pivotal Programs (Very Critical)
   a. Making the Decree of the Board of Directors about changes to the system of acceptance of tin ore, which will be the legal basis in the company, so that each Unit Business in PT. Timah (Persero) Tbk will supporting the implementation of the system.
   b. Conduct socialization to the business units related, is also very important is intended for business partners company owner KIP, because currently most of KIP in PT Timah (Persero) Tbk is the KIP business partners.
   c. Preparing the addition frequency of freight from KIP to PPBT by creating a pattern of tin ore haulage, in order that all transport of tin ore in the region of production can be served.
   d. Increase the number of shift work in PPBT, because with the addition of ore to be processed, the number of working hours must be added in PPBT.
   e. Increase the number of employees due to the addition of the number of hours of work in PPBT and increased the frequency of transport.
   f. Remove the sluice box equipment from any KIP, so that collected is concentrated from the secondary jig, then were taken to the nearest PPBT.

2. Critical Programs
   a. Preparing the laboratory to analyze the tin ore as sample to be analyzed will be increased, whether it's a chemical laboratory in the Unit Metalurgi and Unit Timah Kundur.
   b. Create a program to maintain transport costs per mile per ton of ore, i.e. by creating an effective transportation patterns, thus minimizing transport cost increase per ton of ore.
   c. Create a program to maintain the performance of tin ore processing in PPBT so that recovery of tin ore processing is desired is achieved.
   d. Make routine equipment maintanance program in the PPBT to the desired recovery can be achieved.
   e. Make program cooperation among of Business Unit related in transporting the ore to avoid the accumulation at KIP. Each Business Unit are not wait and let tin ore accumulate in KIP, because it would be seriuos that can disturb the balance the ship.
   f. Making information systems in KIP, ocean freight, and PPBT, so that the information on the stock of tin ore integrated. With this system, transporter can know when is the right time for delivery of tin ore from KIP.
   h. Make a Decree of Directors of bonuses to employees in successful in applying the low grade processing system in KIP. Decree of the Board of Directors as an legal basis about quantity of bonuses that will be given to employees who adapted the role of each.
   i. Create a reward program to business partners with the addition of the value of the contract with the successful changes to this system.
   k. Membuat program pelatihan di bidang pencucian agar recovery pencucian di PPBT bisa dipertahankan. Create training programs in mineral procesing to process recovery in PPBT can be maintained.
   l. Form a team to monitor successful implementation of system changes

In the implementation of a strategy of operation needs to be supported by other functional strategies include policies or short-term decisions that can help in achieving the success of the strategy of the operation itself. To support the success of the ore processing system change in this KIP needed functional strategy with the addition of the following resources:

a. Human Resources Support
   The addition of human resources are needed due to the addition of a scope of work on the PPBT and The ocean freight. The addition of the number of employees in PPBT caused the shift of work in one day will grow. The addition of ocean freight employees needed due to the addition of tin ore transportation frequency from KIP to PPBT.
b. Financial Support
   Operating costs will increase as the cost of fuel for transportation, employee salaries, bonuses to employees, bonuses for business partners, thus requires financial resources.
c. Information Technology Support
   The company has already implemented the SAP to integrate information on the company, but has not yet to get to every KIP. Need to be made the information technology system so that the data stock of ore of tin on KIP can be known by other work units and can schedule the transport so that the tin ore will not be stacked in KIP.

There are several factors that can cause changes to this system, so that these factors should be monitored periodically to suit the desired parameters. Some of the success factors are:

a. Ocean freight capabilities, where The ocean freight was influential for the success of this program, if it can keep the cost of freight per ton of ore as it exists in the calculation. See the experience in the field, because of the tug boat and a barge belonging to a company are often unemployed, so when these costs are optimized, it should come down. But by creating a pattern of lead ore haulage and shipping, expected changes in this system will be successful.
b. Recovery PPBT, where recovery must be able to be maintained for at least the same as the data in 2012 of 98,85%, so the tin metal can make the resulting from the process of washing at PPBT.

If the recovery is lower than that number, then the tin would diminish this washing process and the benefits that accrue from changes to the system will be getting smaller.

c. Management support, where to make that all business units have one vision in carrying out this program, then there must be a direct support from the management company. Without the support of management, The ocean freight will objection if carried a volume of tin ore more, so PPBT would objection if received ore in great numbers, due to the burden of the work will be more and more. Each business unit will be throwing the responsibility of each other if there is no full support from management to change this system.

With the above description, it can be concluded that the change in ore procerssing system KIP from high grade to low grade is worth considering, because it will bring advantages for the company, but also to anticipate some things that can cause a failure of the system change.

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